4N49 Proton Displacement Damage
RLAT Test Report

Log Numbers:
1998
1999
2000

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S. McClure
B. Rax

Electronic Parts Engineering Office
Radiation Testing and Failure Analysis Group
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA

1.0 General

This test report covers proton displacement damage tests performed on Micropac JANTX4N49 lots August 6 and 7, 2001, at UC Davis. The date codes tested included 9810 and 9838, flight lots, as well 9231 which was a spare lot. Tests were performed to determine the acceptability of these lots for the worst case application in the SIRTF Combined Electronics.

2.0 Summary of Results

Both of the flight lots, D/C 9810 and 9838, met the minimum design margin requirement of 2 based on statistical analysis of the data. The spare lot, D/C 9231, was removed from testing when it became clear that it would not meet the design margin requirement.

3.0 Test Procedure

<u>4.1 Test samples -</u> Device is an optocoupler manufactured by Micropac. Device contains a GaAs LED and a silicon phototransistor. Samples were provided by Ball and were military grade hermetic parts. Test samples were identified as follows:

Part Number:	JANTX4N49
Lot Date Codes:	9231 (5 parts)
	9810 (3 parts)
	9231 (5 parts)
Generic:	4N49
Package:	Hermetic can

<u>4.2 Irradiation facility –</u> The irradiation facility used was the proton accelerator at UC Davis, Crocker Nuclear Lab. The proton energy used was 50 MeV and the acceptance criteria for proton fluence was referenced to this energy.

<u>4.3 Electrical tests -</u> Electrical tests were performed using a HP 4156A parameter analyzer. All tests were performed in the pulse mode at 10 us. Electrical tests were performed at three temperatures: 25C (ambient), 37C, and 52C. Device temperature was controlled using a thermoelectric cooler with closed loop control. In no case was the device be operated in a continuous current mode after irradiation. CTR measurements were made with the following conditions for If, Vce and T:

If = 0.5, 1.0, and 2.0 mA
Vce = 1.5V and 5V
T = 25C, 37C and 52C

<u>4.4 Bias conditions –</u> Test samples were unbiased during irradiation, all leads shorted.

<u>4.5 Procedure</u> – Pre-irradiation tests were performed on-site at Davis. All parts were then irradiated to the cumulative fluence levels given below and electrically tested with the above conditions. Exception to this was that D/C 9231 parts were only irradiated to the first level since it was clear that they would not meet the 2X design margin requirement.

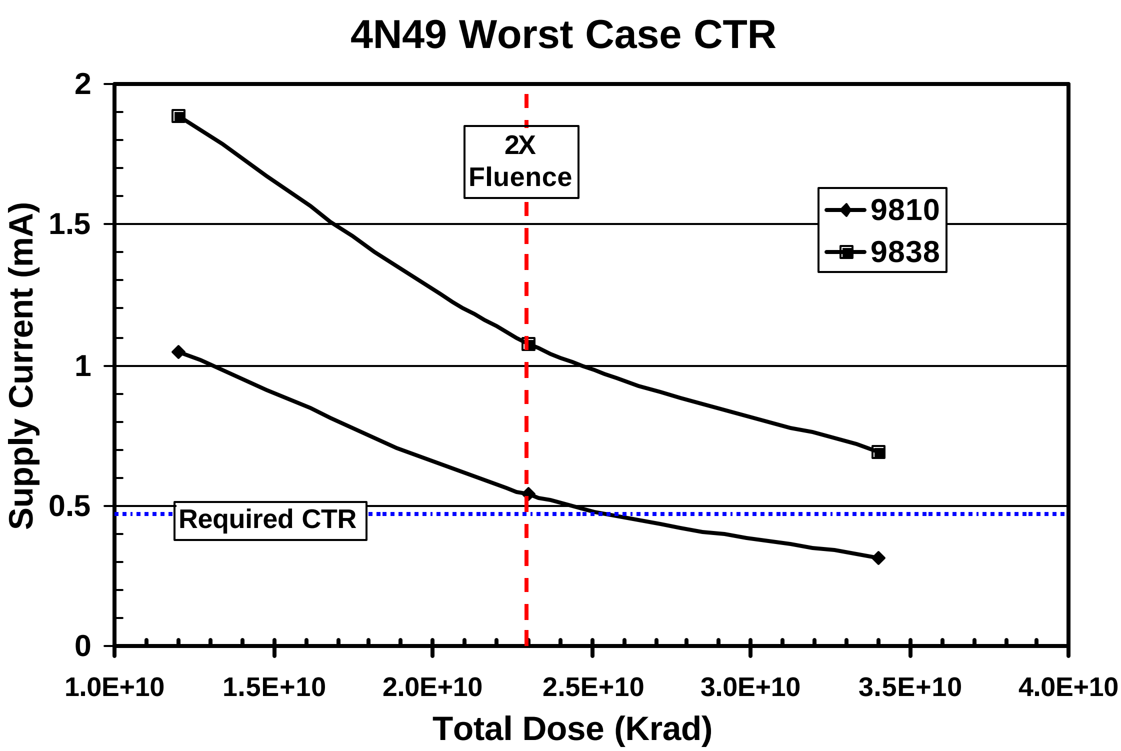
Proton test fluence levels were as listed below (50 MeV equivalent damage in GaAs LED). Design margins provided are based on a calculated environment of 1.14E10 p/cm^2. This environment is based on the NOVICE transport code results provided by BATC for 386 mils Al shield, 2.6 year mission length and the below empirical equivalence factor for GaAs.

Fluence (p/sqcm)	DM JPL
1.2E10	1
2.3E10	2
3.4E10	3

$$F(50\ MeV) = 38/E + 0.24$$

4.0 Test results discussion

Raw test results and worst case CTR calculations are provided in the accompanying Excel file.are provided. For both of the flight lots the acceptance criteria as defined below was met for both the calculated statistical worst case (99/90) and the worst observed values. Below is a plot of the calculated worst case CTR with comparison to the application requirements.



5.0 Acceptance Criteria

The primary physical degradation mechanism in this device is known to be a reduction in LED light output due to carrier removal in the LED. To a lesser extent, there is also a reduction in photosensitivity and reduction in effective gain of the phototransistor with optical excitation. Since, the LED output follows the following relationship for displacement damage.

$$[L_{pre\text{-}rad}/L_{post\text{-}rad}]^{2/3} - 1 = k\Phi$$

CTR will, for the most part, follow a similar relationship, assuming that the LED degradation is the dominant factor. For this reason, use normal distribution statistics on post-rad CTR to determine a worst case is not applicable for this device type. For this test, the worst case CTR was determined from the mean+ three sigma value for "k" for each device within a date code. Worst case CTR was then determined from the above equation using the worst case starting value CTR (mean – 3 sigma). The acceptance criterion for each date code is as follows. At the post-2X fluence value, the post-rad worst case CTR value, at If = 1mA and T = 37C, for each date code must be greater than 0.48. This CTR requirement is based on the worst case application and includes 5% additional post radiation margin for aging.

On exception to this statistical method was applied to the D/C 9838 data. CTR for the test samples from this lot had an unusually tight distribution, <3% variation, while Ball data for a larger number of samples indicated a larger variation, ~10%. For this reason, 10% was used in place of the calculated sigma.